



What We've Done . . .

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October 18-20, 2019

...In 50 Years



What We Said We'd Do (Articles of Incorporation)



The **scientific purposes** for which said corporation is organized shall be the carrying on of scientific research in the public interest by the means of:

- A. **Developing and providing satellite and related equipment and technology** used or useful for amateur radio communication and to conduct experiments by suitably equipped amateur radio stations throughout the world on a non-discriminatory basis.
- B. Encouraging **development of skills and the advancement of specialized knowledge** in the art and practice of **amateur radio communications and space science**.
- C. **Fostering international goodwill and cooperation through joint experimentation and study, and through the wide participation in these activities on a noncommercial basis by radio amateurs of the world.**

...And...



D. Facilitating communications by amateur satellites in times of emergency.

E. Encouraging the more effective and expanded use of the higher frequency amateur radio frequency bands.

F. Disseminating scientific and technical information derived from such communications and experimentation, and encouraging publication of such information in treatises, theses, publications, technical journals or other public means.

G. Conducting such lawful activities as may be properly incident to or aid in the accomplishment of provisions A-F hereinabove, and which are consistent with the maintenance of tax-exempt status pursuant to Section 501(c) of the Internal Revenue Code.  AND THEN THERE IS... I.T.A.R.



So,
We Built Some Satellites
And, Got Them Launched...

It All Started with Australis-OSCAR-V



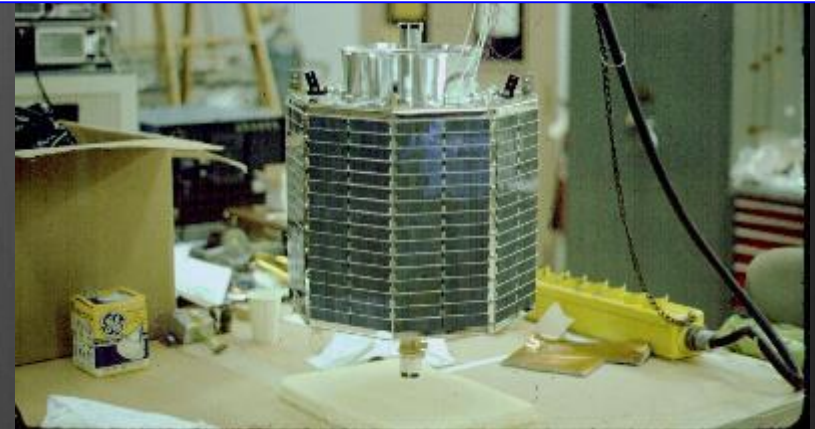
Launched:
January 23, 1970

The 1970s – The Phase-2 (LEO – Long Lived) Satellite Era



AMSAT-OSCAR-6
(Launched: Oct. 1972)

AMSAT-OSCAR-7
(Launched: Nov. 1974 and still working)



- AMSAT
- Project OSCAR
- ARRL



AMSAT-OSCAR-8
(Launched: 1978)



Working as Partners, AMSAT and University of Surrey Developed Two Amateur Scientific Satellites (Many More S/C Followed Under SSTL)



UoSAT-OSCAR-9 / UoSAT-1
(Launched October 1981)



UoSAT-OSCAR-11 / UoSAT-2
(Launched March 1984)

The 1980 – The Phase 3 (Long Lived HEO) Era



AMSAT-Phase-3A
(1980 – Launch
Vehicle Failure)



AMSAT-OSCAR-10
(Launched: 1983)



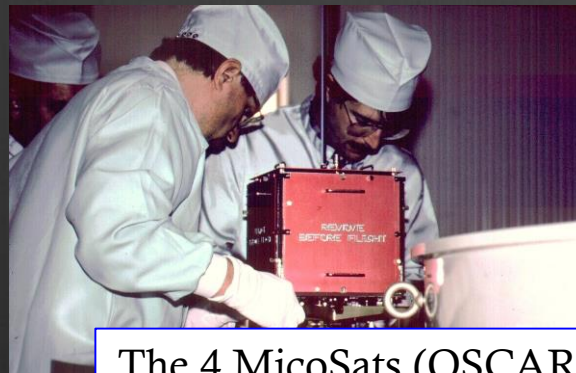
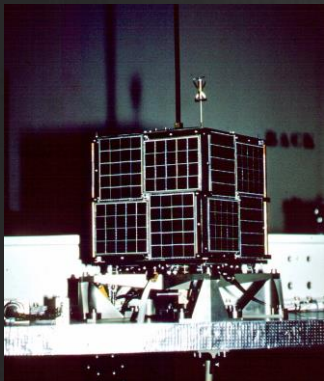
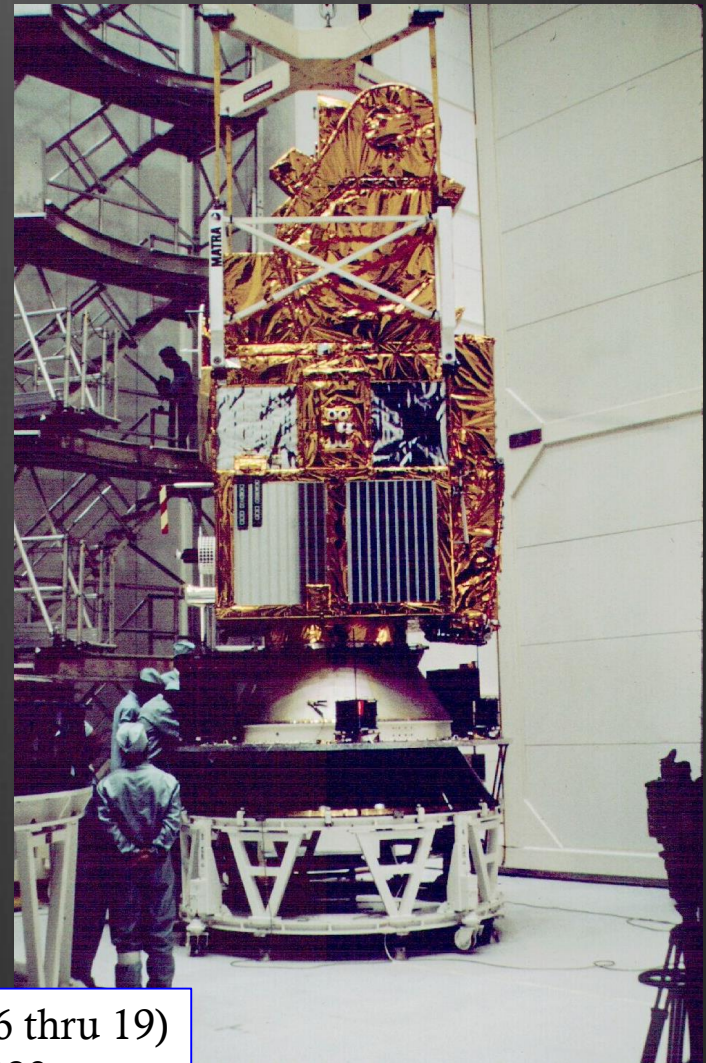
AMSAT-OSCAR-13
(Launched: 1988)

NOTE: Stop Right Here!



- ⦿ Take Note of Our Progress to This Point! This is when Small Space was “Discovered” by the REST of the WORLD.
- ⦿ In Summer 1980 the first “Lite-Sat” Conference was held at the Naval Post-Graduate School, Monterey, CA.
- ⦿ In August of 1986 the AIAA/USU Small Satellite Conference was Established. The first year the attendance was less than 100 people.
- ⦿ This year is the 33rd Year of the AIAA/USU Smallsat Conference. There were 3460 registered attendees from 45 countries, 235 commercial companies and 20 universities. 383 students also attended.
- ⦿ In 1986 AMSAT was celebrating 17 years developing Small Satellites and was at the time building AMSAT-OSCAR-13. Project OSCAR was celebrating its 25th Anniversary.

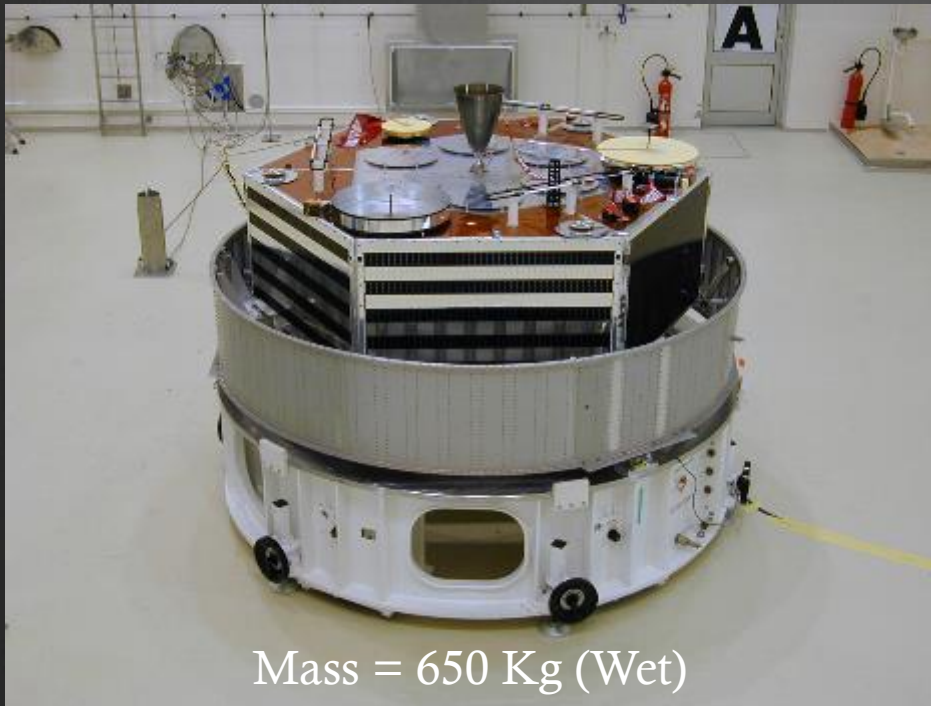
The Early 1990's: Very Small Satellites (The First Launch We Paid For)



The 4 MicoSats (OSCARs 16 thru 19)
Launched: January 1990

The Late 1990's: A Very Large Satellite

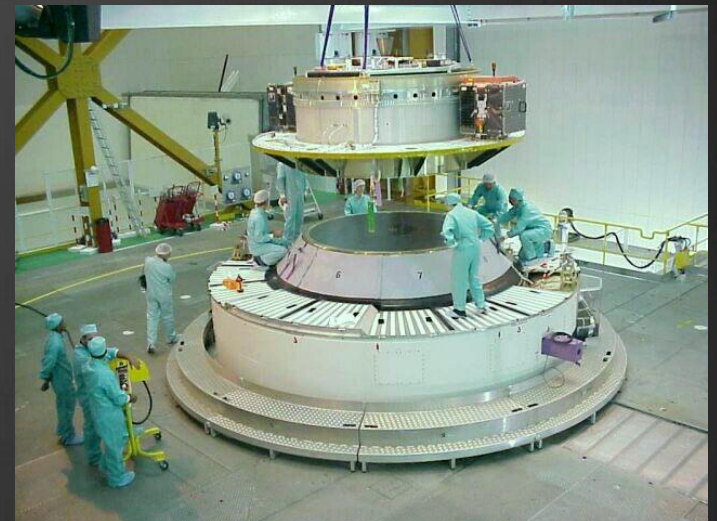
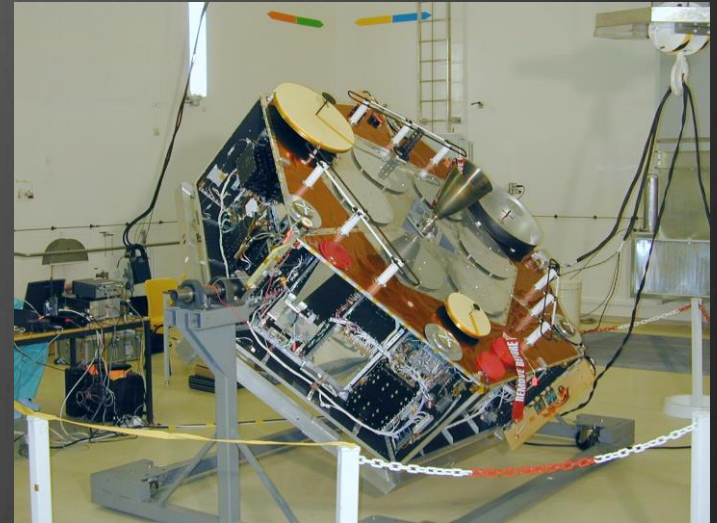
Built by Radio Amateurs from 14 Countries



Mass = 650 Kg (Wet)

AMSAT-OSCAR -40
(Launched: November 2000)

AO-40 Took 1 Decade
To Construct and Launch



From 1978 Onward AMSAT Worked with Very Hazardous Materials at Launch Sites

(This has never been done before or since
by any Amateur Group of any Kind)



Phase-3A:
39.5 Kg of Solid Rocket Motor
Propellant in this Rocket Stage.

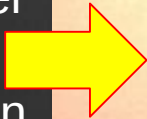


AMSAT Loaded Three Hypergolic (Bi-Propellant) Motor
Systems in Full "Scape". This was SERIOUS business.

A More Capable MicroSat built for AMSAT by SpaceQuest



AO-16
Mass Model
(Now in
Smithsonian
Museum)



AO-51

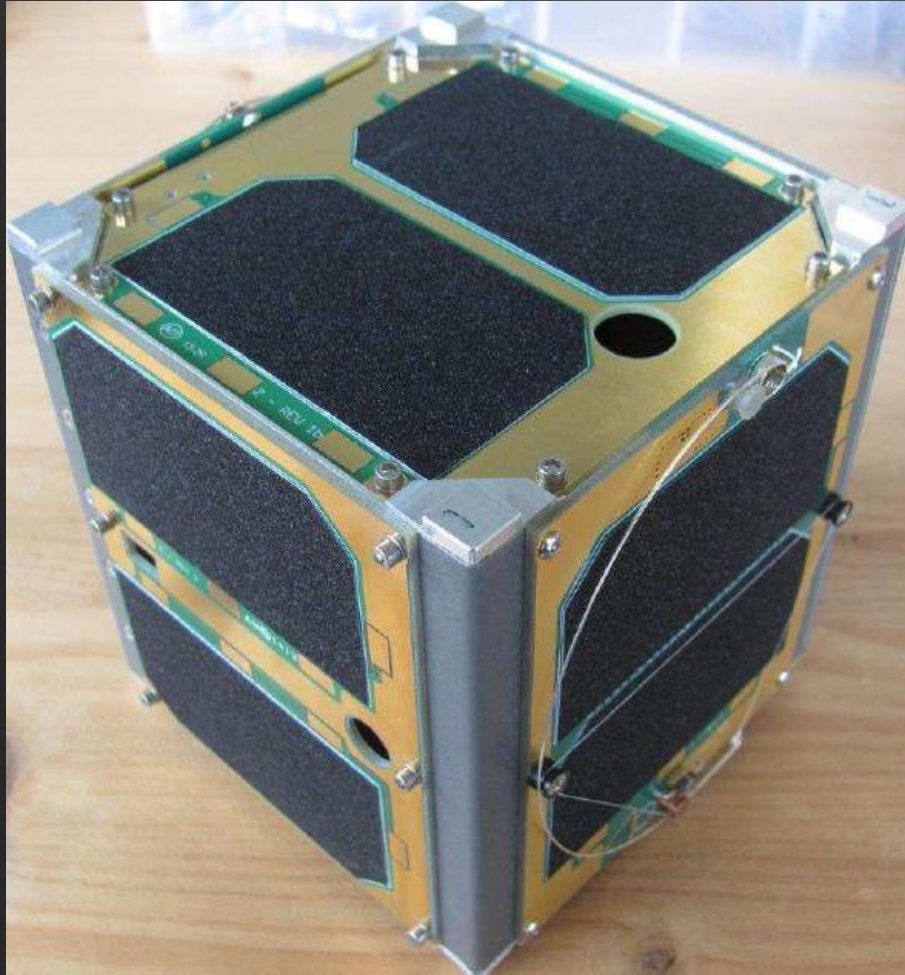
AMSAT-OSCAR-51 (Echo)
Launched: June 2004



And, The Most Recent FOX Series of AMSAT CubeSat Systems



In Partnership with Vanderbilt Univ.



AMSAT-OSCAR 85
Launched 10/8/2015

AMSAT-OSCAR 91
Launched 11/18/2017

AMSAT-OSCAR 92
Launched 1/12/2018

AMSAT-OSCAR 95
Launched 12/3/2018

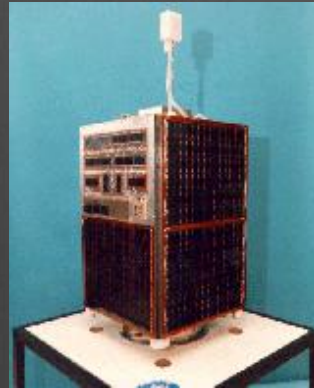
Oh! And, AMSAT Now has a Hosted Payload
on a Real GEO Satellite – Over Europe (25.9°E)



And, Somewhere Along the Way... We Began to Get Lots of Help (Examples):



Fuji-OSCAR-20 (JAS-1b)



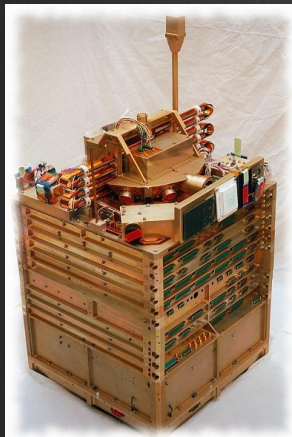
UoSAT-OSCAR-22
(SSTL)



Arsene-OSCAR-24
(France)



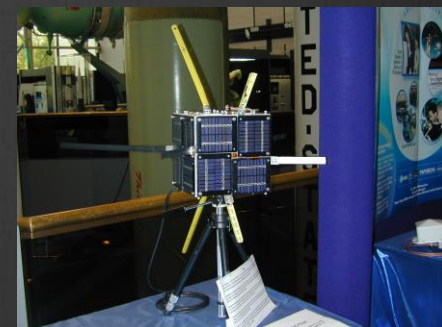
Italy-OSCAR-26



Sunsat-OSCAR-35
(South Africa)



Starshine-OSCAR-43



Nav-OSCAR-44

We Needed Real Space so, we Build an AMSAT Laboratory (1978)



Tom W3IWI and PAO Director at
Ribbon Cutting Ceremony (1978)



Location: NASA/GSFC Space Museum

And, The Sign We Put In That
AMSAT Lab Over the Main
Workbench Read:



“Remember,
It’s Only a Hobby!”

Question: How many times and
by how many people was this advise ignored?

Remember, It's Only a Hobby!



Some Examples I know by Heart

Spacecraft System:	Countries Contributing to Design/Development	Years to Complete System	Man-Years of Volunteer + Paid Labor
AO-7 (Still Working Today)	4	3 Years	10 Man Years
Phase-3A (Launch Failure)	4	5 Years	30 Man Years
AO-16 Thru AO-19 (>10 Yr. Lifetime)	3	2 Years	16 Man Years
AO-40 (< 1 Yr. Lifetime)	14	10 Years	>100 Man Years

And, then there are the Other Spacecraft Not Tabulated Here
Designed/Developed by AMSAT-NA the Major AMSAT Organizations
Globally.

Launch Vehicle Logos

AMSAT's Logo has been
on 5 Ariane Launch Vehicles
(No Other Small Sat Organization Has Had this Honor)



First Ariane 4 Launch: AO-13



Our 2nd Ariane-1 Launch: AO-10

We Didn't Know it But, AMSAT Was About To Start An Industry! How?



⦿ Do You Remember This *:

5.282 In the bands 435-438 MHz, 1260-1270 MHz, 2400-2450 MHz, 3400-3410 MHz (in Regions 2 and 3 only) and 5650-5670 MHz, the amateur-satellite service may operate subject to not causing harmful interference to other services operating in accordance with the Table (see No. 5.43). Administrations authorizing such use shall ensure that any harmful interference caused by emissions from a station in the amateur-satellite service is immediately eliminated in accordance with the provisions of No. 25.11. The use of the bands 1260-1270 MHz and 5650-5670 MHz by the amateur-satellite service is limited to the Earth-to-space direction.

* a.k.a. ITU Footnote 664; Adopted at 1972 WARC

Well Some of Us Do!



- ❁ Some of Us Wrote It and Made It Happen:
 - ❁ K3JTE, Dr. Perry Klein
 - ❁ W4ART, Art Feller
 - ❁ W2RS, Ray Soifer
 - ❁ W3ASK, George Jacobs
 - ❁ W3ZM, Bill Tynan
 - ❁ W3JPT, Chuck Dorian
- ❁ And, This Footnote Created the Amateur Satellite Service (not a good acronym , so ARSS will have to do).
- ❁ AMSAT is the **only non-profit organization** to ever create a Category of Service at the ITU. – At Least a Space Service.

So, All in All There Are a Few
Other Satellite Services and then,
there is US (AMSAT)



- ⦿ **ARSS – Amateur Satellite Service**
- ⦿ EESS – Earth Exploration Satellite Service
- ⦿ FSS – Fixed Satellite Service
- ⦿ ISS – Inter-Satellite Service
- ⦿ MSS – Mobile Satellite Service
- ⦿ MetSS – Meteorological Satellite Service
- ⦿ RDSS – Radio Determination Satellite Service
- ⦿ SOS – Space Operations Service
- ⦿ SRS – Space Research Service

So, ARSS Has It's Own Spectrum?



- ⦿ Pretty Much. And Lots of It. Especially, Compared to Others.
- ⦿ AMSAT Understood the ITU GAME. We've Always Played In It and, We've WON! But, We Can Never Stop.
- ⦿ And, That is a Blessing and a Curse!
- ⦿ Because – Everyone Else Wants This Spectrum Too. Especially the Other Small Satellites, Small Companies and Universities.
- ⦿ Originally, AMSAT had Free and Easy Access to All of This Radio Spectrum...And, We Used Some of It, Very Well, Thank You.

Because We Get Along Best
with the Universities of the
World...



- ⦿ AMSAT participates SIGNIFICANTLY in the IARU Satellite Coordinating Committee.
- ⦿ The U.S. FCC Has “Requested” that we Coordinate Universities who Obtain Amateur Radio Licenses into Amateur Spectrum, Provided That They Comply with the FCC and ITU Radio Regulations Governing Amateur Stations.
- ⦿ So, Over the Year, The IARU SCC Has Coordinated a Few University and “Non-Profit” Organization Satellites Into Our Spectrum.
- ⦿ HOW MANY?

How Many?



This Many!...

Sat Name ↑ ↓	Supporting Organisation ↑ ↓
14-BISat	QB50 & Instituto Federal Fluminense
1KUNS-PF	University of Nairobi
3CAT-4	Universitat Politècnica de Catalunya – Barcelona
3CAT1	Universitat Politècnica de Catalunya – Barcelona TECH
3CAT2	Universitat Politècnica de Catalunya – Barcelona TECH
4M-LXS	Luxspace
Aalto-1	Aalto University, School of Electrical Engineering
Aalto-2	QB50 & Aalto University
Aalto-3	Aalto University
AAUSAT-3	Aalborg University
AAUSAT-4	Aalborg University
AAUSAT-5	Aalborg University
AAUSAT-II	Aalborg University
ACRUX-1	Melbourne Space Program Ltd
Aeneas	University of Southern California
AESP14	Technological Institute of Aeronautics – ITA
AggisSat4	Texas A&M University
AlSat	Aerospace Center Bremen, Uni of Applied Science
ALL-STAR	Colorado Space Grant Consortium
ALMASAT	Universita di Bologna
Alsat-1N	Centre de Développement des Satellites
ANDE	US Naval Academy Amateur Radio Club
ANTELSAT	ANTEL
Anusat-2	QB50 & Anna University
AO 51	AMSAT-NA
AOBA VELOX IV	Nanyang Technological University, Singapore

Aoba-VeloxIII	Kyushu Institute of Technology
Aoxiang-1	QB50 & Shaanxi Engineering Laboratory for Microsatellites,
ARC-1	Alaska Space Grant Program
ARCE-1A/1B/1C	University of South Florida College of Engineering
ArduSat-1	ArduSat Inc
ArduSat-X	ArduSat
Argus-01	Parks College, Saint Louis University
Argus-2	Parks College, Saint Louis University
Armadillo	University of Texas at Austin Satellite Design Laboratory
ArtSat-1-Invader	Tama Art University
ArtSat-2 - Despatch	Department of Information Design, Tama Art University
Astrocast 0.1 & 0.2	Amateurfunkverein der Hochschule Luzern
Athenox	Microspace Rapid Pte Ltd
ATL-1	Budapest University of Technology and Economics
Atlantis	QB50 & University of Michigan
AtmoCube	INAF- Astronomical Observatory of Trieste
Aubiesat X	Auburn University Student Space Program
AUTcube2	Aich University of Technology
AZTECHSAT-1	Universidad Popular Autonoma del Estado de Puebla
BarnacleSat	Montana State University
BeEagleSat	QB50 & Istanbul Technical University
BEESAT-2	TU Berlin
BEESAT-3	TU Berlin
BEESAT-4	Technische Universität Berlin
BEESAT-9	TU Berlin
Bevo-2	University of Texas at Austin Satellite Design Laboratory
BHUTAN-1	Kyushu Institute of Technology
BIRDS -B,-G,-J,-M	Kyushu Institute of Technology

BIROS	Technische Universität Berlin (TU Berlin)
BisonSat	Salish Kootenai College
Black Knight-1	United States Military Academy
BLUEsat	University of New South Wales
BRICsat	US Naval Academy
Brite-PL1	Space Research Centre Polish Academy of Sciences
Brite-PL2	Space Research Centre Polish Academy of Sciences
BugSat-1	Satellologic S.A.
BUSAT-1	QB50 & School of Astronautics, Beihang University
BY70-1	China Center for Aerospace Science and Technology
CADRE	University of Michigan
CAMSAT_BUAASat-1	Chinese Amateur Satellite Group
CanX-2	Institute for Aerospace Studies-Toronto University
Canyval-X	Astrodynamics and Control Lab. Yonsei Univ
Cape III	University of Louisiana at Lafayette
Cape-2	Cajun Advanced Picosatellite Experiment
CAPE1	Cajun Advanced Picosatellite Experiment
CAS-3 Constellation	CAMSAT
CAS-4A & CAS-4B	Chinese Amateur Satellite Group (CAMSAT)
CAS-5A	Chinese Amateur Satellite Group - CAMSAT
CAS-5B	Chinese Amateur Satellite Group - CAMSAT
CAS-6	Chinese Amateur Satellite Group - CAMSAT
CAS-7A	Chinese Amateur Satellite Group - CAMSAT
CAS-7B	Chinese Amateur Satellite Group - CAMSAT
Castor	Naval Research Laboratory
Centennial-1	Booz Allen Hamilton
ChargerSat-1	University of Alabama in Huntsville
CHOMPTT	University of Florida

ChubuSat-1	Komaki Amateur Radio SATCOM Club (TBD)
ChubuSat-2	Komaki Amateur Radio SATCOM Club
ChubuSat-3	Komaki Amateur Radio SATCOM Club
CisLunar Explorers 1 & 2	CisLunar Explorers Satellite Project
CLAVIS-1 (AISat payload)	German Aerospace Centre, Institute of Space System
CNUSAIL-1	Chungnam National University, Department of Aerospace Engineering
Compass -1	University of Applied Sciences Aachen Germany
COPPER	Parks College, Saint Louis University
CP1	Cal Poly Aerospace Engineering
CP10-Exocube	PolySat
CP2	Cal Poly Aerospace Engineering
CP3	PolySat
CP4	Cal Poly United Amateur Radio Club
CP5	Polysat, Cal Poly State University
CP6	Polysat
CP8	Cal Poly United Amateur Radio Club
CP9	CalPoly
CSIM	Laboratory for Atmospheric and Space Physics
CSSWE	LASP
CSUNSat1	California State University
CTIM	University of Colorado
CUAVA-1	ARC Training Centre for CubeSats, UAVs, and Their Applications (CUAVA), University of Sydney, School
CubeBell	Belarus State University
CubeBug-1	Ministry of Science, Technology & Productive Innovation
CubeBug-2	Ministry of Science, Technology and Productive Innovation
CubeSAIL	The Surrey Space Centre

CubeSail-1	University of Illinois
Cubesat XI-V	Intelligent Space Systems Lab - Univ of Tokyo
CubeSTAR	Fysisk Institutt
CUNYSAT-1	Medgar Evers College
CUSat	Cornell Univ Space Systems Lab
CUTE-1.7+APD	Tokyo Institute of Technology
Cute-1.7+APD II	Laboratory for Space Systems, Tokyo Institute of T
CXBN	Morehead State University Space Science Center
CXBN-2	Morehead State University Space Science Center
CySat-1	Iowa State University
D-Sat	CNIT
D-STAR-ONE	German Orbital Systems
Dande	CU-Colorado Space Grant Consortium
DAVE/CP7	Cal Poly
DelfFFi-Delta	QB50 & Delft University of Technology (TU Delft)
DelfFFi-Phi	QB50 & Delft University of Technology (TU Delft)
Delfi-C3	Delft University of Technology
Delfi-n3Xt	Delft University of Technology
Delfi-PQ	Delft University of Technology
Delphini-1	Aarhus University – Department of Engineering
Delta-Dsat	QB50 & Cranfield University
Deorbisail	The Surrey Space Centre
Descent	Lassonde School of Engineering @ York University
Discovery	QB50 & Stanford University
Diwata-2	PHL-Microsat
DIY-1 - Arduiqube	DiySatellite Group
DragonSAT-1	Drexel University
Dragsail-CubeSat	QB50 & FH Aachen

Dream Sat 01	Osaka Institute of Technology
DSLWP-A1/A2	Harbin Institute of Technology
DSM-BRAC	University of Michigan
DTUSat-2	Technical University of Denmark
Duchifat-1	Herzliya Science Center
Duchifat3	Herzliya Science Center
DUTHSAT	QB50/Democritus University of Thrace
DynaCube	Denel Dynamics
e-st@r	RI – Sezione di Bra (Ham Radio Club) & POLITECNICO
E-Star-2	Politenco di Torino
Eagle-1	Morehead State University
Eagle-2	Morehead State University
EagleSat-1	Embry Riddle Aeronautical University
EcAMSat	Santa Clara University
EdgeCube	Sonoma State University
EDSN	Santa Clara University
Egycubesat-1	National Authority for Remote Sensing and Space Sciences
EIRSAT-1	University College Dublin
Elfin-A	University of California
Elfin-B	University of California
EnduroSat A	Association Tsiolkovsky
EntrySat	ISAE-SUPAERO
EQUISat	Brown University
ESEO	University of Bologna
ESTCube-1	University of Tartu, Estonia
Es'hail-2	Es'hailSat
ExAlta-1	QB50 & Dept of Physics, University of Alberta
ExoCube2/CP12	Cal Poly

Explorer1Prime	Montana State University
ExseedSat	Exseed Space Innovations Pvt Ltd
F-1	FSpace laboratory, FPT Corporation, Hanoi, Vietnam
FACSAT	Colombian Air Force Academy
Falconsat 3	US Air Force Academy
Fastrac-1	University of Texas Satellite Design Lab
Fastrac-2	University of Texas Satellite Design Lab
FCAL-Stensat 2	NRL Amateur Radio Club
FEES	GP Advanced Projects srls
Firebird A&B	Montana State University
FIREBIRD-2	Montana State University Space Science and
First MOVE	Lehrstuhl für Raumfahrttechnik, TU München
Fitsat-1	Fukuoka Institute of Technology
FLORIPASAT-1	Federal University of Santa Catarina
Flying Laptop (FLP)	University of Stuttgart
FMN-1	Link Space Aerospace Technology
Foresail-1	Aalto University
FossaSat-1	AMSAT-EA
Fox-1A	The Radio Amateur Satellite Corporation (AMSAT)
Fox1-C	The Radio Amateur Satellite Corporation (AMSAT)
Fox1-D	The Radio Amateur Satellite Corporation (AMSAT)
FUNCube-1/AO73	AMSAT-NL
GAMASAT	QB50 & Faculty of Engineering of the University of Porto
GeneSat-1	Inland Northwest Space Alliance
Genesat-2	Cntr for Robotic Exploration & Space Technologies
GoldenEagle-1	Marquette University
Goliat	University of Bucharest
GOMX-1	GomSpace Aps

GOMX-2	GomSpace Aps
GOMX-3	GomSpace Aps
Grifex	University of Michigan
HA-1	Teenagers Amateur Radio Center of Activity in Huaian
HAM-TV	AMSAT Italia
HAUSAT-1	Hankuk Aviation University - Seoul
HavelSat	QB50, Havelsan & Istanbul Technical University
Hawksat1	Hawk Institute for Space Sciences
Heimdallr	AMSAT-NA
Hermes	Colorado Space Grant Consortium
HFSAT	US Naval Academy
Hiakasat	Hawaii Space Flight Laboratory, University of Hawaii at Manoa
HiNCube	Narvik University College
Hit-Sat	Hokkaido Institute of Technology
Hoopoe/IL01	QB50 & Herzliya Science Center - 4X4HSC
Horyu-3	Kyushu Institute of Technology
HORYU-4	Kyushu Institute of Technology
Horyu-I	Kyushu Institute of Technology, Fukuoka, Japan
Horyu-II	Kyushu Institute of Technology
Ho`oponopono-2	University of Hawaii At Manoa
HSKSAT	HSK Amateur Radio Club
Humsat-D	University of Vigo
HuskySat-1	Husky Satellite Lab at the University of Washington
ICEcube1 & 2	Cornell University
ICUBE-1	Institute of Space Technology - Islamabad
IGOSat	Paris Diderot University
IITMSAT	Indian Institute of Technology Madras
INCA - Ionospheric Neutron Content	New Mexico State University NanoSat Lab

InflateSail	QB50 & Surrey Space Centre
InKlajn-1	INSA - The Israeli Nano-Satellite Association
InnoSAT-2	Astronautic Technology M Sdn Bhd
Inspire2	QB50 & The University of Sydney
ION	University of Illinois
Irvine01	Woodbridge High School
Irvine02	Woodbridge High School
Istsat-1	Instituto Superior Técnico & AMRAD (AMSAT-CT)
ISX/CP11	Cal Poly
IT-SPINS	Montana State University
ITASAT-1	Technological Institute of Aeronautics – ITA
ITF-1/YUI	University of Tsukuba
ITF-2	University of Tsukuba
ITUpSAT-1	Istanbul Technical University
JAISAT-1	The Radio Amateur Society of Thailand
Jugnu	Dept of Elec Engineering, IIT Kanpur, India
Juvenile	China Soong Ching Ling Youth Science and Culture Center
JY1SAT	Royal Jordanian Radio Amateur Society
K2SAT	Republic of Korea Air Force Academy
KatySat1	Stanford Space Systems Development Laboratory
KauSat-5	Space System Research Laboratory, SSRL, Korea Aerospace University
KickSat	Cornell University
KickSat-2	Cornell University
KIWI sat	AMSAT-NZ
KKS-1	Metropolitan Col. of Ind. Technology- To
Knacksat	King Mongkut University of Technology North Bangkok

KPI-SAU-1	QB50 & National Technical University of Ukraine, Kiev Polytechnic Institute
KrakSat	Integra AGH
KUTESat-Pathfinder	University of Kansas
KySat-2	Kentucky Space LLC
Kysat1	Kentucky Science and Technology Corporation
LAICE-1	University of Illinois
Lambdasat	San Jose State University
Lapan Tubsat	Indonesian Aeronautics and Space Institute
Lapan-A2	Indonesia Institute of Aeronautics and Space(LAPAN
Lapan-Orari	Indonesia Institute of Aeronautics and Space(LAPAN
Libertad 1	Sergio Arboldea University Colombia
LightSail-1	Cal Poly State University
LightSail-A	CSC Department, Cal Poly
LightSail-B (now LightSail -2)	California Polytechnic State University
LilacSat-1	QB50 & Harbin Institute of Technology (HIT)
LilacSat-2	Harbin Institute of Technology
Link	QB50 & Korea Advanced Institute of Science and Technology
LithuanicaSAT-2	QB50 & NPO Innovative Engineering Projects
LitSat1	Lithuanian Space Association
LituanicaSAT-1	NPO Innovative Engineering Projects
LQSat	Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP)
Lucky-7	SkyFox Labs s.r.o.
LUME-1	University of Vigo
M-Cubed	University of Michigan
MAESAT	Nanyang Technological University
Masat-1	Budapest University of Technology and Economics,
Max Valier Sat	Istituto Tecnologico (TFO / Technologische Fachoberschule)

MAYA-1	Kyushu Institute of Technology
MCubed-2	University of Michigan, Department of Aerospace Engineering
Mea Huakai Voyager	University of Hawaii
MemSat-1	Rowan University
Merope	Montana State University
MinXSS	University of Colorado
MinXSS-2	University of Colorado
MIR-SAT1	MRC - Mauritius Research Council
MIST	KTH Space Centre, Stockholm
MiTEE-1A	The University of Michigan
Move-II	Technische Universität Munchen
Move-IIb	Technische Universität Munchen
Mr & Mrs Sats	Missouri University of Science and Technology
Mursat-1	mur.at
myPocketQub 391	Gruppo di Astrodinamica Università degli Studi Sap
MYSat-1	Masdar Institute of Science and Technology
NanoSail-D	Center for Robotic Exploration and Space Technolog
NanoSail-D2	Center for Robotic Exploration and Space Technolog
Nanosatc-BR	National Institute of Space Research -Brazil
NANOSATC-BR2	National Institute for Space Research – INPE/MCTI
Narkissos-1	Spacebooth
Nayif-1/EO88	American University of Sharjah
Ncube-1	Norwegian Univ of Science & Technology
Ncube-2	Norwegian Univ of Science & Technology
Negai (was Exelsior)	Soka University
NepaliSat-1	Kyushu Institute of Technology
NetSat	Zentrum für Telematik e.V.
Nexus	Department of Aerospace Engineering, Nihon University

NJUST-1	QB50 & Nanjing University of Science and Technology
NMSUSat	New Mexico State University
Nodes	Santa Clara University
NPS-SCAT	Naval Postgraduate School
nSIGHT1	QB50 & SCS-Space
NUDTSat	QB50 & National University of Defense Technology
NuSat-1 and NuSat-2	Satellologic S.A. & AMSAT-LU
NUTS	NTNU, Department of Electronics and Telecommunication
O/OREOS	Center for Robotic Exploration and Space Technolog
Oculus-ASR	Michigan Technological University
OGMS-SA	QB50 & Université Paris-Est Creteil
Omotenashi	JAXA Ham Radio Club
OpenOrbiter 1	University of North Dakota
OPS-SAT	European Space Agency - ESOC
OPUSAT	Osaka Prefecture University Small Spacecraft Systems Research Center
Opusat-II	Small Spacecraft System Research Center Osaka Pref University
OrigamiSat-1	Tokyo Institute of Technology
ORS-Squared	COSMIAC at the University of New Mexico
OSIRIS-3U	The Pennsylvania State University
OSSI-1	Open Source Satellite Initiative
OUFTI-1	University of Liège
P-Sat-A & P-Sat-B	US Naval Academy Amateur Radio Club
PACE	National Cheng Kung University
Painani-II	Universidad del Ejercito y Fuerza Aerea
Paradigm/Bevo1	The University of Texas at Austin
Parikshit	Manipal Institute of Technology
PCSAT2	US Navy Academy

Pegasus	QB50 & Fachhochschule Wiener Neustadt
Pehuensat	AMSAT Argentina
PharmaSat	Cntr for Robotic Exploration & Space Technologies
Phase 3E	AMSAT-DL
PHOENIX	QB50 & National Cheng Kung University
Phoenix CubeSat	Arizona State Univeristy
PhoneSat v2	NASA Ames Research Center
Phonesat-v1	NASA Ames Research Center
PicoDragon	Vietnam National Satellite Center
Picpot 1	Politecnico di Torino
PicSat	CNRS/LESIA - Observatoire de Paris
Pocket-PUCP	Pontificia Universidad Catolica del Peru
Politech.1	Universidad Politécnica de Valencia
Pollux	Naval Research Lab Amateur Radio Club
PolyITAN-1	National Technical University of Ukraine
POPSAT-Hip1	Microspace Rapid Pte Ltd, Singapore
PQ-Gemini++	Micro-Space Inc
Pratham	Dept of Aerospace Eng, IIT Bombay, India
Printsat	Montana State University
Prism-1	Intelligent Space Systems Lab, U of Tokyo
Proiteres	Proiteres Development and Operation Team
Proiteres 2	Osaka Institute of Technology
Prox-1	Georgia Institute of Technology
PSAT-2	US Naval Academy
PTecSat	-Info not provided-
PUCP-SAT-1	Pontificia Universidad Catolica del Peru
PW-Sat	Warsaw University of Technology
PW-Sat2	Warsaw University of Technology

Q-PACE	University of Central Florida
QARMAN	QB50 & the Von Karman Institute for Fluid Dynamics
QB50p1/EO79	The Von Karman Institute for Fluid Dynamics
QB50p2	The Von Karman Institute for Fluid Dynamics
QB50_US01_Challenger	QB50 & University of Colorado
QB50_US04_Columbia	QB50 & Universidad del Turabo
qbee01/SW01	QB50 & Luleå Tekniska Universitet (LTU)
QBITO	QB50 & E-USOC, ETSI de Aeronáuticos, Universidad Politécnica de Madrid
QIKCom-1	US Naval Academy
QIKcom-2	US Naval Academy
Qubescout-S1	UMBC Physics Dept-LACO
QUETZAL-1	Universidad del Valle de Guatemala
Raavana-1	Kyushu Institute of Technology
RACE	The University of Texas at Austin; Texas Spacecraft Laboratory
RadFXSat	The Radio Amateur Satellite Corporation (AMSAT)
RadFxSat-2	AMSAT-NA
RadSat-g	Montana State University
RadSat-u	Montana State University
RAFT	US Naval Academy ARC
Ralphie & Sparkie	New Mexico State University Amateur Radio Club
RANGE A & B	Georgia Institute of Technology
RAX	University of Michigan
RAX-2	University of Michigan
Reaktor Hello World	Reaktor Innovations
RECONSO	Georgia Institute of Technology
Rincon	University of Arizona at Tuscon
RoBiSAT-1	QB50 & Institute of Space Science, Romania

RoBiSAT-2	QB50 & Institute of Space Science, Romania
Robusta	IES - Université Montpellier 2
Robusta 1b	CSU (Centre Spatial Universitaire) – Université Montpellier 2
Romit-1	European Lunar Exploration Association
RSP-00	Rymansat Project
RSP-01	Rymansat Project
S-Net (a constellation of 4 sats)	Technische Universität Berlin
SACRED	University of Arizona at Tuscon
SAFIR-S	AATiS e.v.
SamSat-QB50	QB50 & Samara State University
SAT-IP2	QB50 & INSSET
Sathyabamasat	Sathyabama University
SEAM	KTH Royal Institute of Technology
SEEDS	Dept of Aerospace Eng - Nihon Univ Japan
SeeMe	Raytheon Missile Systems
Serpens	University of Brasilia
SFAB-01	Amateur Radio Interest Group of Shanghai Tech University
SGSat.KySat-3	University of Kentucky
Shin-En2	Kagoshima University
Shindai-sat	Shinsyu University
skCUBE	SOSA Radio OM3KAA
SME-SAT	The Surrey Space Centre
SMOG-1	Budapest University of Technology and Economics,
SMOG-P	Budapest University of Technology and Economics
SNAPS	SSDL - Stanford University
Snuglite	Seoul National University
SNUSAT-1	QB50 & Seoul National University
SNUSAT-1b	QB50 & Seoul National University

SNUSAT-2	Seoul National University
SOHLA-1	Astro-Technology SOHLA
SOMP	DresdenTechnische University
SOMP-2	QB50 & TU Dresden
SONATE	University of Würzburg – Department of Computer Science VIII
Sorunsat-1	Sorun Ham Club Tokyo
SpaceCube	QB50 & Mines Paristech
SpinSat	Chantilly Academy
SPOC	The University of Georgia Small Satellite Research Laboratory
SpooQy-1	National University of Singapore
SporeSat	Santa Clara University
Sprout	Dept of Aerospace Engineering, Nihon University
SRMSAT	SRM University India
SSETI-Express	European Space Agency
Star of Aoxiang	Northwestern Polytechnical University
STARS	Kagawa University
Stars-AO	Shizuoka University
Stars-C	Shizuoka University
STARS-II	Kagawa University
STARS-Me	Shizuoka University
STEP-1	Chosun University, Gwangju, Republic of Korea
STMSat-1	not provided
STRaND	Surrey Space Centre
STU-1	QB50 & ShanghaiTech University
Studsat	Nitte Meenakshi Institute of Technology
SUCHAI	University of Chile
SumbandilaSat	SA AMSAT
Suomi 100	Aalto University, School of Electrical Engineering

SUPERNOVA-BETA	Pumpkin Inc
SurfSat	University of Central Florida
SUSat	QB50 & The Institute for Telecommunications Research
Swampsat (was Gatorsat)	Gator Amateur Radio Club @ the Univ of Florida
Swayam COEP	College of Engineering Pune
Swiatowid	SatRevolution S.A.
Swisscube	Ecole Polytechnique Fédérale de Lausanne
Swisscube 2	Space Center, Ecole Polytechnique Fédérale de Laus
Tancredol	Tancredo de Almeida Neves
TARO	National Cheng Kung University
Taurus-1	Aerospace System Engineering Research Institute of Shanghai
TBEX	University of Michigan
TechEdSat-1	National Center for Advanced Small Spacecraft Technology
TechnoSat	Technische Universität Berlin
TeikyoSat-3	Space System Research Group of Teikyo University
TeikyoSat-4	Space System Society of Teikyo University
Ten-Koh	Kyushu Institute of Technology
Tethersat1 & 2	Naval Research Laboratory
TIANZHI-01	Institute of Software, Chinese Academy of Sciences
TIIsat-1	Uni of Applied Sciences of Southern Switzerland
TJ3Sat	Thomas Jefferson High School
TJREVERB	Thomas Jefferson High School for Science & Technology
Trailblazer-1	COSMIAC at the University of New Mexico (UNM)
Triton-1	ISIS-BV
Triton-2	ISIS BV
TRSI	TRSI Club
TSUBAME	Laboratory for Space Systems, Tokyo Institute of T
TTU100	Tallinn University of Technology

TTU101	Tallinn University of Technology
Tu-POD	Gauss Srl
TURKSAT-3USAT	Istanbul Technical University
TY-1	Shaanxi Engineering Lab for Microsatellites, NW Polytechnical University
TY2 -TY3 -TY4 -TY5 -TY6	Hunan Amateur Radio Society
Uapsat	Radio Club Peruano
Ubakusat	Istanbul Technical University
UCISAT-1	University of California -Irvine
UCLSat	QB50 & UCL/MSSL
Uguisu	Kyushu Institute of Technology
UiTMSAT-1	Kyushu Institute of Technology
UKube-1 with FUNcube-2	University of Strathclyde & the UK Space Agency
Ulises-1	National Institute of Astrophysics Optics and Electronics, Mexico
Unicorn-1	SpaceBooth VOF
UNICubeSAT	Scuola di Ingegneria Aerospaziale Universtà di Rom
UniSat-5	GAUSS
UniSat-6	Gauss
Unitec-1	University Space Engineering Consortium
Unix Space Server (USS) Langley	US Naval Academy
UNSW-EC0	QB50 & The University of New South Wales
UPMSat-2	Universidad Politecnica de Madrid
UPSat	QB50 & University of Patras
Ursa Maior	QB50 & Universita' di Roma "La Sapienza"
USNA-P1/BricSat-1	US Naval Academy
UWE-1	Julius Maximilians University, Wurzburg, Germany
UWE-2	University of Wuerzburg, Department of Computer
UWE-3	University of Wuerzburg, Department of Computer

UWE-4	University of Wuerzburg
Velox-P	Nanyang Technological University
Velox-P11	Nanyang Technological University
Venta-1	Ventspils University College
Vermont Lunar CubeSat	Vermont Technical College Amateur Radio Club
Violet	Violet Lab Cornell University
VisionCube	Korea Aerospace University
VUSat/Hamsat	
VZLUSAT-1	QB50 & Aerospace Research and Test Establishment
Warp-1	University of Tsukuba
Waseda-Sat3	Waseda University
Waseda.sat	Waseda University
We-Wish	Meisei Amateur Radio Club
Wren	StaDoKo UG
Xatcobeo	Universidade de Vigo
XCubesat	QB50 & Ecole Polytechnique
XW-1	CAMSAT
YamSat	National Applied Research Laboratories, Taiwan
YUSAT-1	National Taiwan Ocean University
YUSend-QB50	QB50 & Centre for Research in Earth and Space Science, Lassonde School
Z-Sat	Komaki Amateur Radio SATCOM Club
ZA-AeroSat	QB50 & Stellenbosch University
ZACube-1	F'SATI, Cape Peninsula University of Technology
ZACube-2	F'SATI, Cape Peninsula University of Technology

As Of . . .



- **Mid-September, 2019**, The International Amateur Radio Union Satellite Coordinating Committee has Coordinated into Amateur Radio Satellite Spectrum (in Accordance with ITU Footnote 5.282 and Largely Using Article 4.4 of the Radio Regulations):

522 Small Satellites

And, Then There Are...



🎬 As of Mid-September 2019:

🎬 The Applications in the Queue...

Sat Name ↑ ↓

Supporting Organisation ↑ ↓

Neutron-1	University of Hawaii, Hawaii Space Flight Laboratory
ESTCube-2	Institute of Physics, University of Tartu
TY1-03	Human Amateur Radio Society
TY1-04	Human Amateur Radio Society
TY7-01	Human Amateur Radio Society
Velox-AM	Satellite Research Center, Nanyang Technological University
CELESTA(Robusta-1D)	Université de Montpellier
IDEASSat	Graduate Institute of Space Science National Central University
APSS-1	The University of Auckland, Faculty of Engineering
Aistechsat-2	Aistech Space
TRISAT	University of Maribor
SwampSat II	University of Florida
Q-PACE-1	University of Central Florida
Surya Satellite-1	Department Physics and Energy Engineering at Surya University
Orbital Factory 2 (OF-2)	The University of Texas at El Paso
AMICal Sat	UGA-CSUG France & SINP MSU & NILAKT Russia
KOSEN-1	National Institute of Technology, Kochi College
Tsuru	Kyushu Institute of Technology
GuaraniSat-1	Kyushu Institute of Technology
Maya-2	Kyushu Institute of Technology
CAS-8A	Chinese Amateur Satellite Group - CAMSAT
CAS-8B	Chinese Amateur Satellite Group - CAMSAT
CAS-8C	Chinese Amateur Satellite Group - CAMSAT
CAS-8D	Chinese Amateur Satellite Group - CAMSAT
LORIS	Dalhousie University

1

Satellites to be Coordinated:

25

So, This Coordination Process:



- ⦿ Is not Fun (Talk To Art or Ray for the Inside Scoop)
- ⦿ Is Labor-Intensive (Usually Multiple Go-Arounds with Applicant)
- ⦿ Is FREE to the Applicant
- ⦿ Generates Nothing Tangible for the Amateur Radio Community – Especially Now.
- ⦿ May Generate Some Good Will

Thus, I Maintain, IMHO...



~~ARSS = Amateur Satellite Service~~



Is Now

SSS = Small Satellite Service

(Managed as a FREE Service to the WORLD)

By the Former Amateur Radio Satellite Service Practitioners)

Oh and Amateur Radio Operators Can Use This Spectrum Too...

If They Can Find a Place to Transmit.



The “Firsts” and “Bests”

- AND -

OUR HIGH WATER MARK

AMSAT Flying on NASA Delta Launches



- ❁ First Non-Government Secondary Payload –AO-5 (1970)
- ❁ First International (Non-US) Secondary Payload- AO-5
- ❁ First Amateur Radio/University Student Project –Australis-OSCAR-5 (University of Melbourne, Australia)
- ❁ First Command Sent to an Amateur Satellite. First Use of the 10M frequency band by a spacecraft. (Australis-OSCAR-5)
- ❁ First Secondary Satellite System to Systematically Qualify as a “Compatible Co-Passenger” to be Flown Along Side a Formal NASA Primary Spacecraft (AO-6 Flew With ITOS-D in 1972).

AMSAT Flying on NASA Delta Launches (2)



- ❁ First Amateur Spacecraft and First Secondary Payload to Use a Standard Delta L/V Payload Attach Fitting (AO-7 Used a Standard 9" Delta Marmon Clamp Band in 1974 on Delta 104 – Shared with INTASAT (Spain on the Same Launch).
- ❁ First Secondary Payload to Qualify for the Use of On-Board Pyrotechnic Devices for Deployment of a Boom Element (AO-7; Deployment of two 10M *Stacer*® Antenna Elements, 1974).

❁ **Oldest Still Functioning Spacecraft In EARTH ORBIT.**

- ❁ **AMSAT-OSCAR-7**

- ❁ **Delta 104**

- ❁ **Launch Date: 15 November 1974**

AMSAT Flying on Ariane Launches



- ❁ We were a Passenger on the First Ariane to Carry Payloads (LO-2 - 1980)
- ❁ First Secondary Payload Passenger on Ariane (LO-2)
- ❁ First Launch Vehicle Failure of an Amateur Satellite (LO-2)
[NOTE: Not Our Fault]
- ❁ First Successful (Almost) User of Ariane SYLDA Device (LO-6 – 1983). AMSAT was Co-Primary Passenger on this Flight! Another AMSAT First.
- ❁ Passenger on First Ariane-4 Launch Vehicle (and First Secondary Payload on Ariane-5). (V-22 – 1988).
- ❁ Only Ariane Passenger to Fly on Ariane-1, Ariane-4 and Ariane-5. And, from all 3 Launch Pads.

AMSAT

Space Technology Firsts



- ❁ First Use of an **Advanced High Efficiency Linear Amplifier Using Parametric Synthesis (HELAPS)** Technology (Karl Meinzer, DJ4ZC; Mode B Transponder; AO-7; 1974; In Partial Fulfilment of Karl's PhD Thesis Requirement). 2nd @ 3rd Generation HELAPS Technology Used on AO-10, AO-13, AO-16 and AO-40. **IT IS STILL WORKING!**
- ❁ First Non-Government Use of “Store and Forward” Information Transfer (Code Store Experiment, AO-7, 1974). This preceded AX.25 Packet Radio by some years. (John Goode, W5CAY). This was prior to all non-government and all non-amateur uses of this technology.
- ❁ First Use of AX.25 “Store and Forward” Packet Radio Data Transfer Technology (DCE). (UO-11 – 1984) (Harold Price NK6K, TAPR, Univ. of Surrey). This also superseded the commercial use of this technology.
- ❁ First non-Commercial Packet Store-and-Forward mini-Constellation (AO-16 thru LU-19). [Many, many GB of data transferred via AX.25 over 10 years.] **Thanks to Tom, W3IWI who put heart and soul into this one.**

AMSAT

Space Technology Firsts (2)



- ⊗ First Use of Morse Code and RTTY as purely digital telemetry data protocols (an alternative to more complex forms of binary coded data used by professional organizations). This opened the way for very simple means of telemetry data decoding. This provided a very simple educational example of how digital data can be used to represent sequentially sampled analog measurements. (AO-6 - 1972; AO-7 - 1974).
- ⊗ First Use of CMOS Integrated Circuits in Space by Any Spacecraft (AO-6 and it's primary co-passenger NASA's ITOS-D share this honor BUT, AO-6 Outlived the NASA Primary Spacecraft.
- ⊗ Oldest CMOS Integrated Circuits Still Working in Space (AO-7; 45 years; RCA-4000 series logic family; 1460 km, 101 ° inclined orbit).

AMSAT

Space Technology Firsts (3)



- ❁ First Spacecraft to Use a Microprocessor with a Real Time Operating System (RTOS) as its Sole Means of Mission Control (TT&C). (Karl Meinzer, DJ4ZC developed IPS to Run on the RCA 1802 COSMAC μ P; Phase-3A, 1980).
- ❁ First Use of a Peak Power Tracker on Board Any Spacecraft (Karl Meinzer DJ4ZC Design; AO-7 BCR). **NOTE:** The term BCR = Battery Charge Regulator, first used by AMSAT on AO-7, is in Universal International Use Today throughout the Small Satellite World.
- ❁ First Use of a “Photon Propeller” (Using the Sun to Intentionally “Spin” a Spacecraft) by Any Spacecraft (Karl Meinzer, DJ4ZC Design; AO-7 VHF/UHF Antenna System Also Used to Spin Spacecraft About Z Axis. Verified by John Fox, WØLER Telemetry Data Analysis). Used Successfully again on AO-8, AO-16, DO-17, WO-18, LuO-19.

AMSAT

Space Technology Firsts - PROPULSION (1) –

(These Are Not Only Firsts; They are ONLYs)



- ❁ First Secondary Payload Satellite of Any Kind Able to Qualify to Use a Solid Propellant Rocket Motor on a Secondary Payload (Phase-3A, 1980).
NOTE: Spacecraft Failed to Achieve Orbit due to Ariane LO2 L/V Failure. This remains the only satellite to attempt to use such a large SRM as a Primary Means of Orbit Modification.

TM-345-12
Motor was
donated to AMAT
by Morton Thiokol,
Elkton, Div.



Propellant Mass:
39 Kg
Isp = 270 sec
 $\Delta V = 1450$ m/sec

AMSAT

Space Technology Firsts - PROPULSION (2) –

(These Are Not Only Firsts; They are ONLYs)



- ❁ First Uses of Bi-Propellant Spacecraft Propulsion Systems by any Secondary Payload. This is never likely to be repeated. AO-10 Was First. Launch: Ariane-LO-6, 1983.

400N Bi-Prop
Motor Donated
by MBB,
Lampoldshausen,
Germany.
Symphony S/C
Spare AKM.



Propellant Mass:
 $\text{UDMH} + \text{N}_2\text{O}_4$
= 65 Kg
 $I_{sp} = 303 \text{ sec}$
 $\Delta V = 1700 \text{ m/sec}$
1st Burn: Successful
(Too Long)
2nd Burn:
Not Successful

AMSAT

Space Technology Firsts - PROPULSION (3) –

(These Are Not Only Firsts; They are ONLYs)



- ⦿ AMSAT's High Water Mark: The Performance of AO-13:
Both Burns 100% Successful.



400N Bi-Prop
Motor Donated
by MBB,
Lampoldshausen,
Germany.
S/C
Spare AKM.

Propellant Mass:
 $\text{UDMH} + \text{N}_2\text{O}_4$
 $= 65 \text{ Kg}$
 $I_{\text{sp}} = 303 \text{ sec}$
 $\Delta V = 1700 \text{ m/sec}$
1st Burn: Successful
2nd Burn: Successful

AMSAT's High Water Mark (IMHO)

ConOps
Conducted
by:
• DJ4ZC
• KA9Q



Starting Orbit: $h_p = 210$ km; $h_a = 36,250$ km
 $i = 7.0^\circ$

1st Burn Orbit: $h_p = 2545$ km; $h_a = 36,250$ km
 $i = 17.0^\circ$

AMSAT-OSCAR-13 (Phase-3C) Bipropellant Motor Burn Performance

NOTE:

<u>Parameter:</u>	<u>Post-Burn Target:</u>	<u>AMSAT Ranging Solution:</u>	<u>NORAD Radar Solution (MH7-12):</u>	<u>Units:</u>
Epoch Time:	188.88144	188.88144	188.88144	day
Inclination:	57.46	57.40	57.65	degrees
RAAN:	248.13	248.11	248.15	degrees
Eccentricity:	0.6561	0.6536	0.6539	-
Arg. Of Perigee:	187.25	186.95	186.97	degrees
Mean Anomaly:	167.41	168.77	168.64	degrees
Mean Motion:	2.09920	2.09695	2.09698	rev/day
Semi-major Axis:	25,764	25,784	25,783	km
Apogee Height:	36,288	36,259	36,265	km
Perigee Height:	2,484	2,553	2,545	km
Delta-V of Burn:	1309.7	1306.6	1313.6	m/s
ALON:	301.8	299.4	299.2	degrees
ALAT:	-70.8	-71.5	-71.4	degrees

2nd Burn Orbit

AMSAT

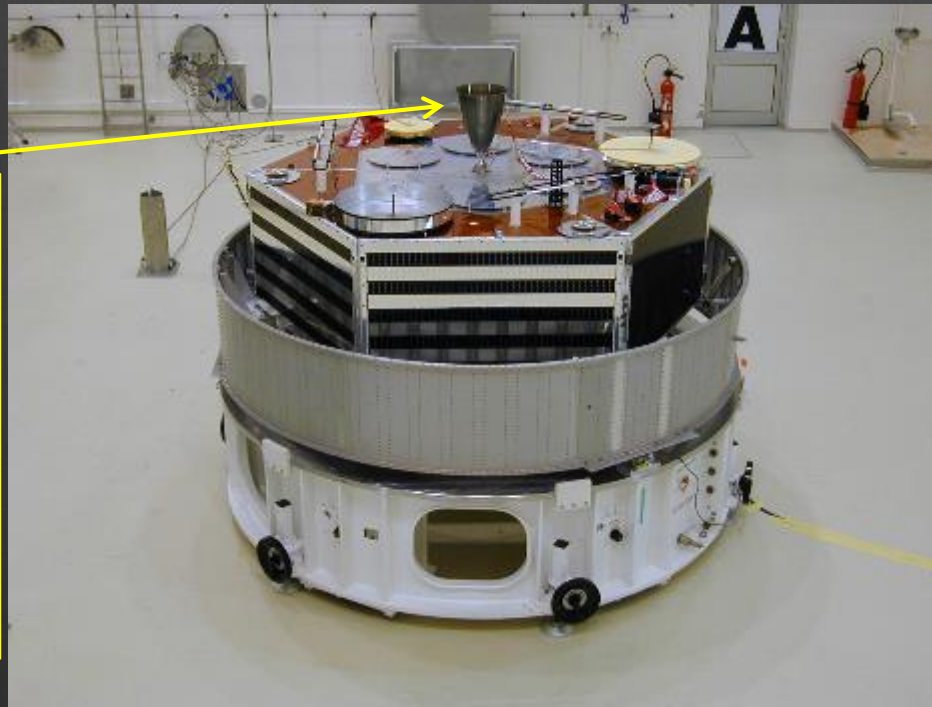
Space Technology Firsts - PROPULSION (3) -

(These Are Not Only Firsts; They are ONLYs)



First and ONLY Bi-Prop System
EVER to Experience a Non-
Catastrophic Propulsive Failure!!!

🎬 AMSAT's BIG Propulsion System:



400N Bi-Prop
Motor Donated
by MBB,
Lampoldshausen,
Germany.
Cassini S/C Spare
Trajectory Adjust
Motor.

Propellant Mass:
 $\text{MMH} + \text{N}_2\text{O}_4$
 $= 244 \text{ Kg}$
 $I_{\text{sp}} = 318 \text{ sec}$
 $\Delta V = 1470 \text{ m/sec}$
1st Burn:
Partially Successful.
Nozzle has larger
Expansion Ratio

Yes, the JPL Saturn Cassini Spare! This was worth \$Millions of USD

AMSAT

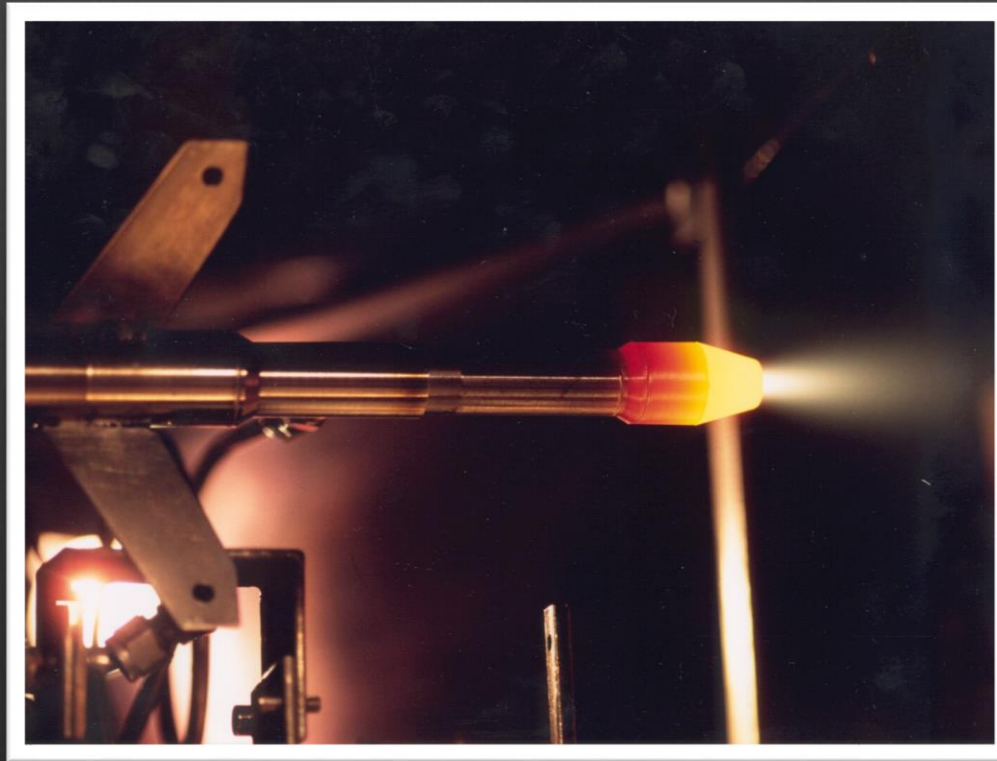
Space Technology Firsts - PROPULSION (4) –

(These Are Not Only Firsts; They are ONLYs)



Developed by Universities of Stuttgart and Dresden

NH₃ Plasma
Motor
Thrust = 0.5 N
 $I_{sp} = 550-600 \text{ sec}$
 $\Delta V =$
200-300 m/sec



Operated
Only
In Cold Gas
Blow-Down
Mode.

2nd Propulsion System on AO-40

Oh, We Wrote a Little Software Too...

QUESTION: Do you think it is likely that others outside the amateur community benefitted some from our free or nearly free application code?



Software for MS Windows

Windows software is organized into the following categories:

WiSP

WiSP Accessories

The Station Program

Rotor Control Programs

Satellite Tracking Programs

Radio Tuning Programs

IPS Programming

Telemetry Programs

Packet Radio Programs

Image Display Programs

Analysis Programs

Utility Programs

Miscellaneous Programs

AMSAT Software Pioneers:

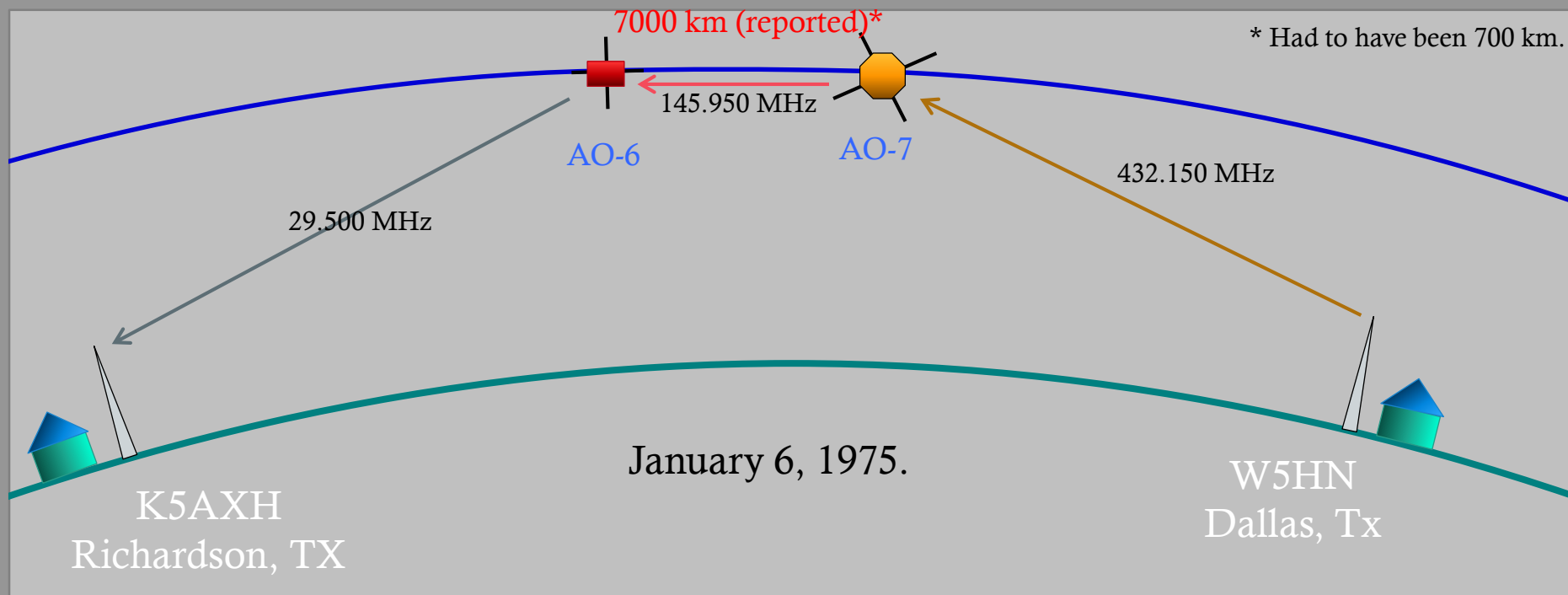
- Dr. Tom Clark W3IWI
- Dr. Karl Meinzer DJ4ZC
- Harold Price NK6K
- Phil Karn KA9Q
- Franklin Antonio
- Joe Bijou
- Richard Allen W5SXD
- Dr. Bob McGwire N4HY



Operational Firsts

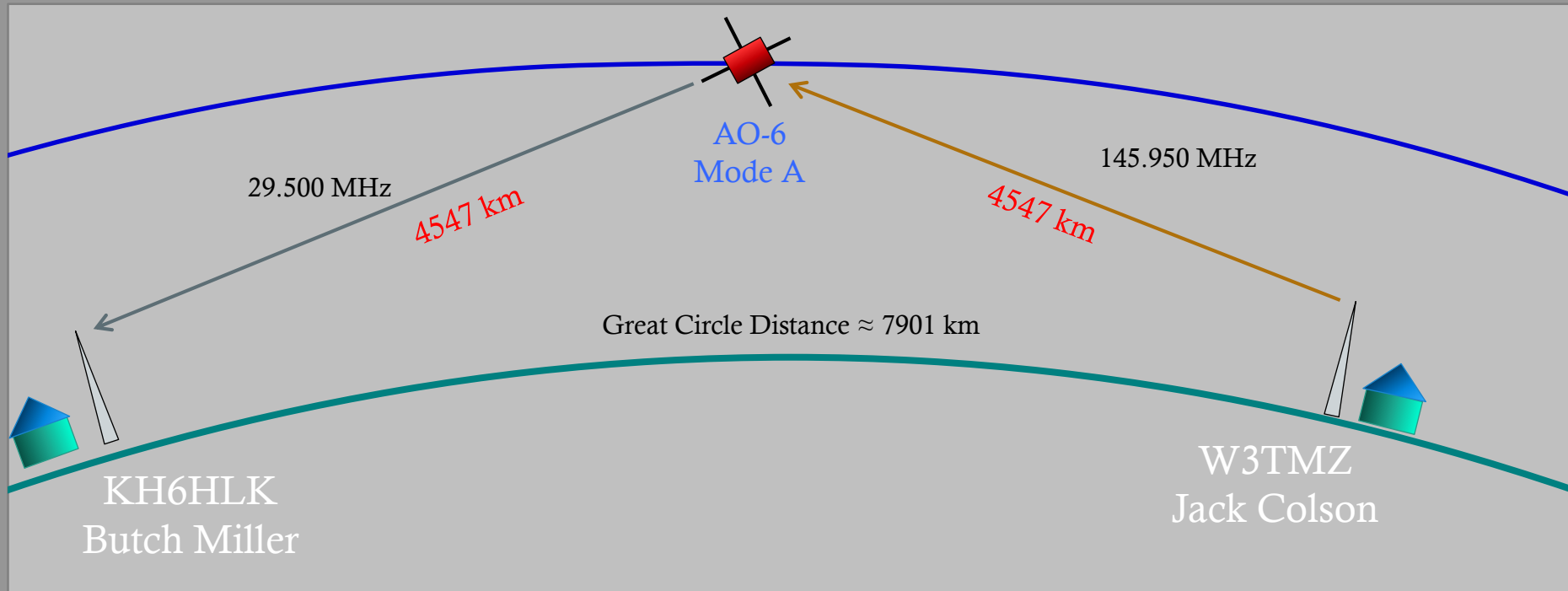
Frequency Bands Used

First Earth-Space-Space-Earth Communications Relay Demonstration Ever



- Reported by P. Klein (K3JTE) and Ray Soifer (K3QBW), Proceedings of the IEEE, Vol. 63, Issue 10, October 1975, pp. 1526-27.
- 55 Amateur Stations in 12 Countries did this during 1975.

Longest AO-7, LEO Communications (QSO) Demonstration Ever



- Near-Zero Elevation Angles both side of link.
- This Allowed Jack to Complete his **Satellite-WAS**
- Fantastic Achievement!

AO- 6 & AO-7 Participation in NASA/GSFC Demonstration of COSPAS/SARSAT



- ❁ COSPAS/SARSAT is a Joint Search and Rescue Program, Originally Between Russia and the United States; Now its Fully International.
- ❁ System Uses EPIRB and ELT Transmitters on frequencies of 121.5, 243.0 (military only) and 406 MHz.
- ❁ System Tracks Distress Beacons on these frequencies and provides a Doppler Location Solution of the Distress Signal Location.
- ❁ Rescue Services then Track Beacon Locally when in Close Proximity.
- ❁ **The VERY FIRST Demonstrations of this Capability were Carried out by NASA, with AMSAT support, using AO-6 and AO-7, 2m-10m Transponder (Mode A). The Results were Very Successful.**
- ❁ Program Lead and NASA/GSFC: Dr. Dan Brandel.

AO- 6 & AO-7 Participation in NASA/GSFC Demonstration of COSPAS/SARSAT (2)



- Between September 1982 and December 2017 the Cospas-Sarsat System has provided assistance in rescuing **at least 46,553 people** in **13,627 SAR events**.
- In 2015, 2016 and 2017 (the latest year for which statistics have been compiled), Cospas-Sarsat assistance included the following:



Year:	People Rescued:	SAR Events:
2017	2,746	963
2016	2,057	876
2015	2185	718

SAR Events:	2017	2016	2015
Aviation:	17%	20%	17%
Maritime:	41%	40%	48%
Land:	42%	40%	35%

So, What Frequency Bands Were Used On ALL These Satellites?



- ⊗ ANSWER: I'm not even sure.
- ⊗ It's a good question for the IARU Satellite Coordination Committee Who have COORDINATED by now more than 500 Small Satellites into spectrum used under FN 5.282 of the ITU.
- ⊗ ESSENTIALLY ALL THESE BANDS WERE USED AT LEAST ONCE:
 - ⊗ All Conventional HF Bands: 7.0 MHz – 29.5 MHz
 - ⊗ 144 – 146 MHz (145.9-146 primary)
 - ⊗ 435-438 MHz
 - ⊗ 1260-127- MHz ↑
 - ⊗ 2400-2450 MHz
 - ⊗ 3400-3410 MHz ?
 - ⊗ 5650-5670 MHz ↑
 - ⊗ 10.49 – 10.50 GHz
 - ⊗ 24.00 – 24.05 GHz

} Your Future is Here but, BE QUICK

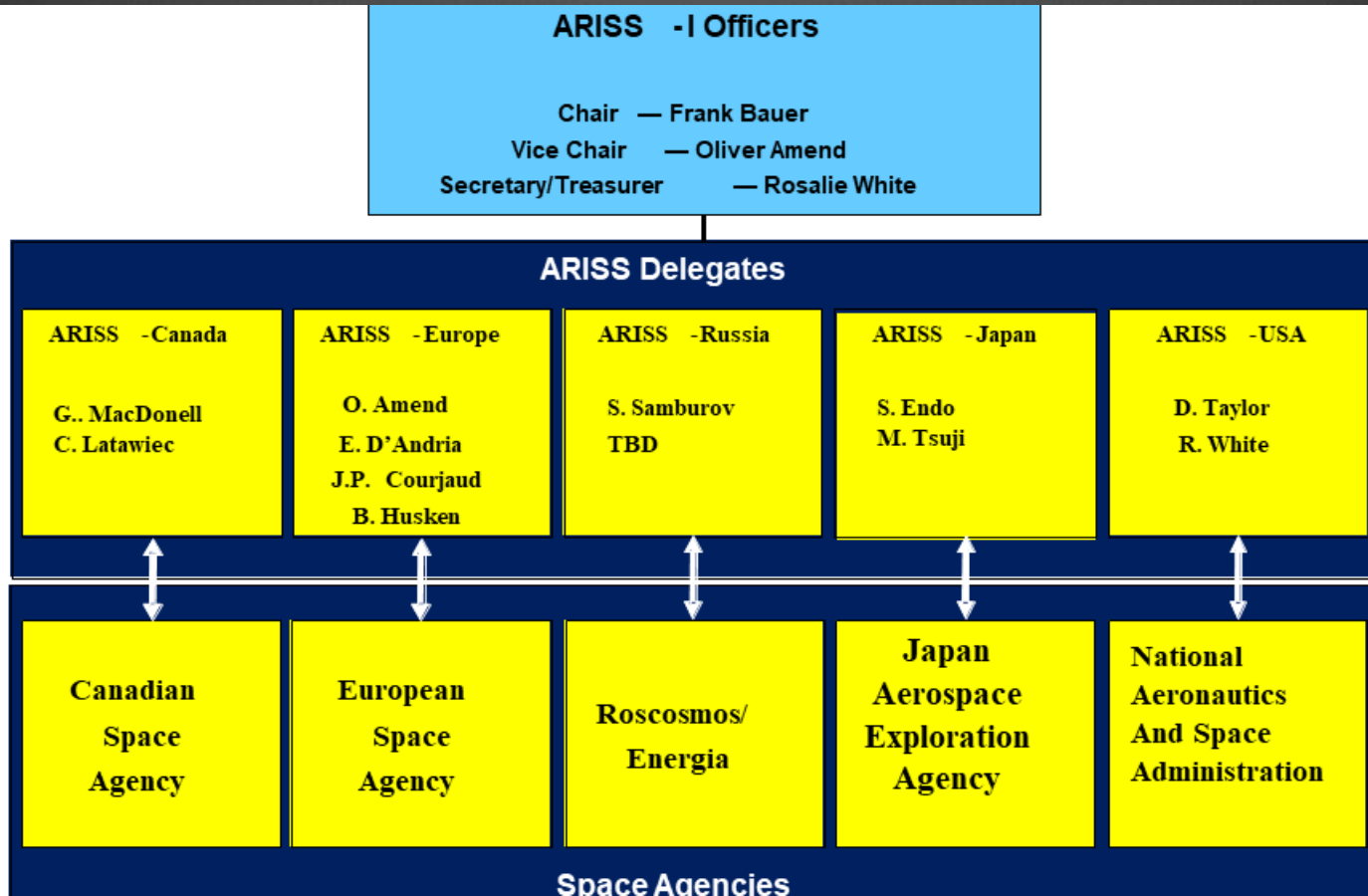
And, Now We're Half Done...



And **SAREX** before it.

- ⦿ And, What Has Been Presented is Only about ½ of What We've Done.
- ⦿ What About the Manned Side of Amateur Radio in Space?
- ⦿ In Fairness, this has been EVEN MORE IMPORTANT than the SmallSat side of What We've Done. And, I Can't Do it Justice. It must be presented For It's Own Sake.
- ⦿ It Has Had Much Higher Social Impact on ALL of Us!
- ⦿ **If you'd been 12 Years Old and Had the Chance:**
 - ⦿ **I Wonder if You'd Remember that First Day You Talked to An Astronaut From Space?**
 - ⦿ **Nah!**

For Some of it's Part, AMAT has
Created and Qualified Critical ISS Radio
Frequency Hardware...
AND WE NOW HAVE THIS:



Which Has Accomplished This:



Successful ARISS Events (Schools) per year

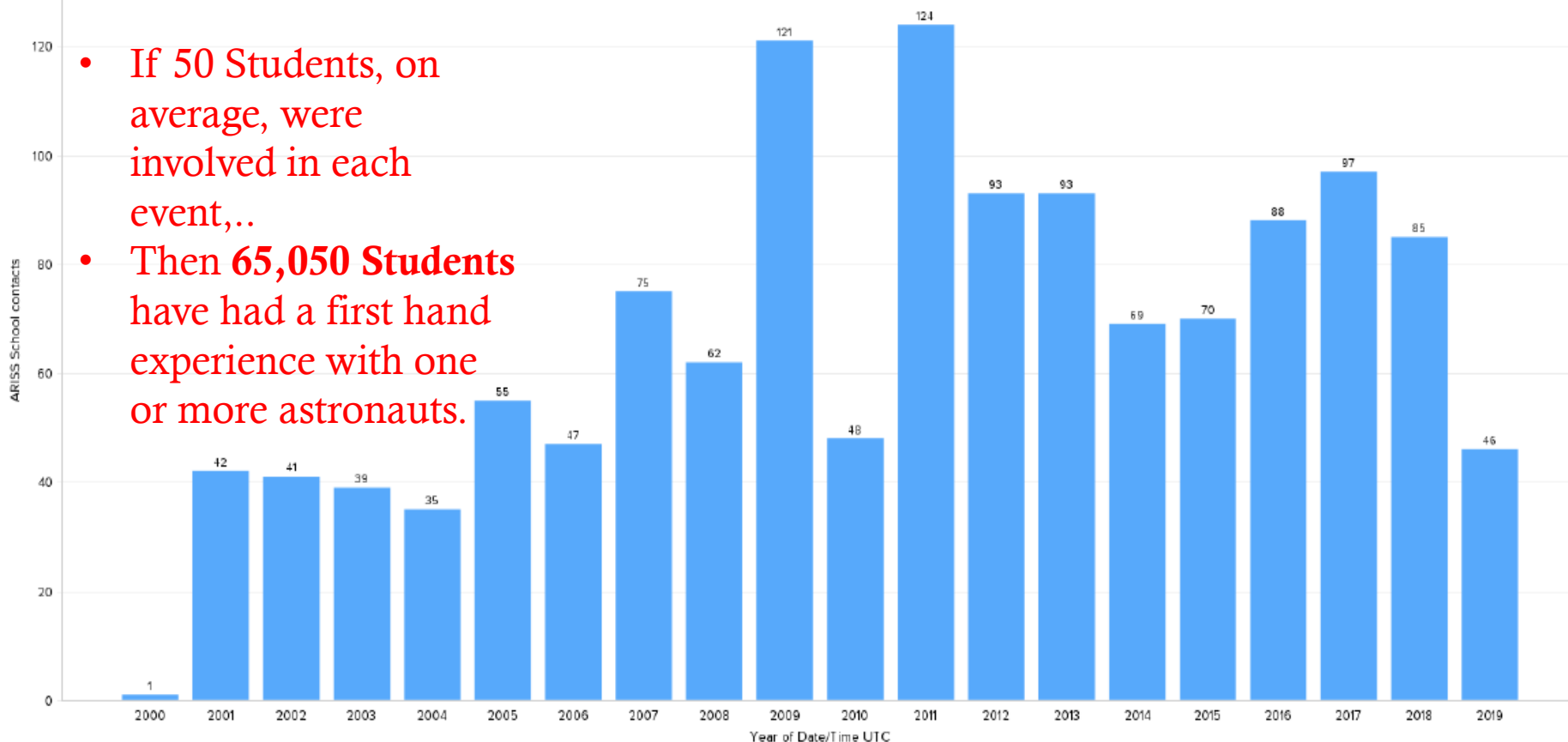
Tue Sep 24 2019 03:28:59 GMT

1301 Successful School Events in 20 Years:

Successful ARISS Events (Schools) per year

Count of the successful events per country separated per year

- If 50 Students, on average, were involved in each event,..
- Then **65,050 Students** have had a first hand experience with one or more astronauts.



And, We Kept the Members Fed ...And, They Fed Us!



- ⊗ AMSAT Nets
- ⊗ AMSAT News Service (ANS)
- ⊗ AMSAT Area Coordinator System
- ⊗ AMSAT Publications
 - ⊗ AMSAT Newsletter; AMSAT-UK and AMSAT-DL Publications
 - ⊗ Orbit Magazine
 - ⊗ AMSAT Technical Journal
 - ⊗ ARRL Gateway
 - ⊗ AGM Symposium Proceedings

...and They Fed Us!



FUND RAISING

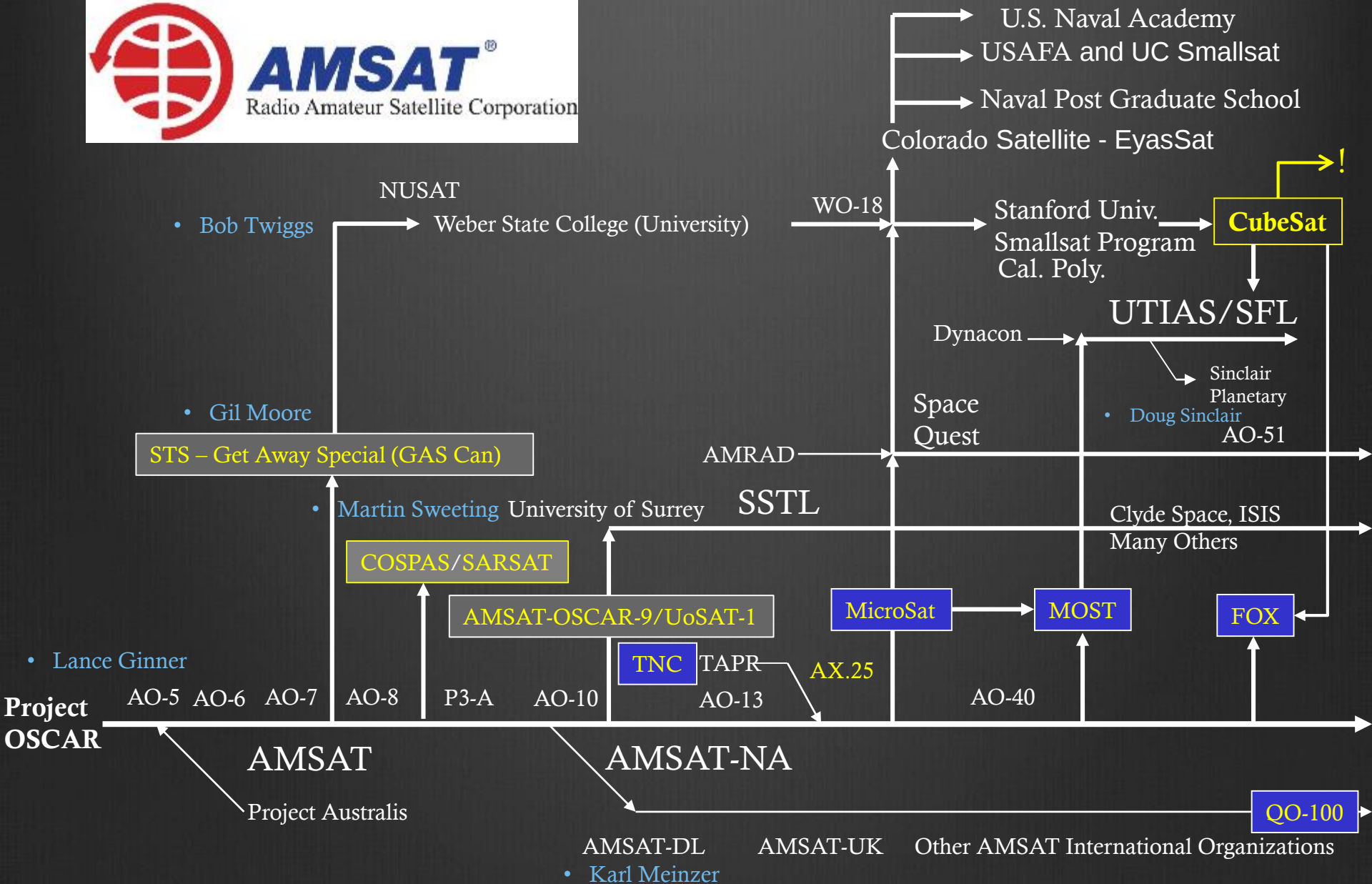
- ❁ Thank You To ALL The Presidents of AMSAT!
- ❁ Thanks to ALL Our Members Over All These Years!
- ❁ Little Old AMSAT did ALL of THIS with NOT SO MANY PEOPLE
- ❁ But, the Money HAD to come from Somewhere...
- ❁ SOMEHOW, WITH LOTS OF WORK... IT ALL WORKED OUT!



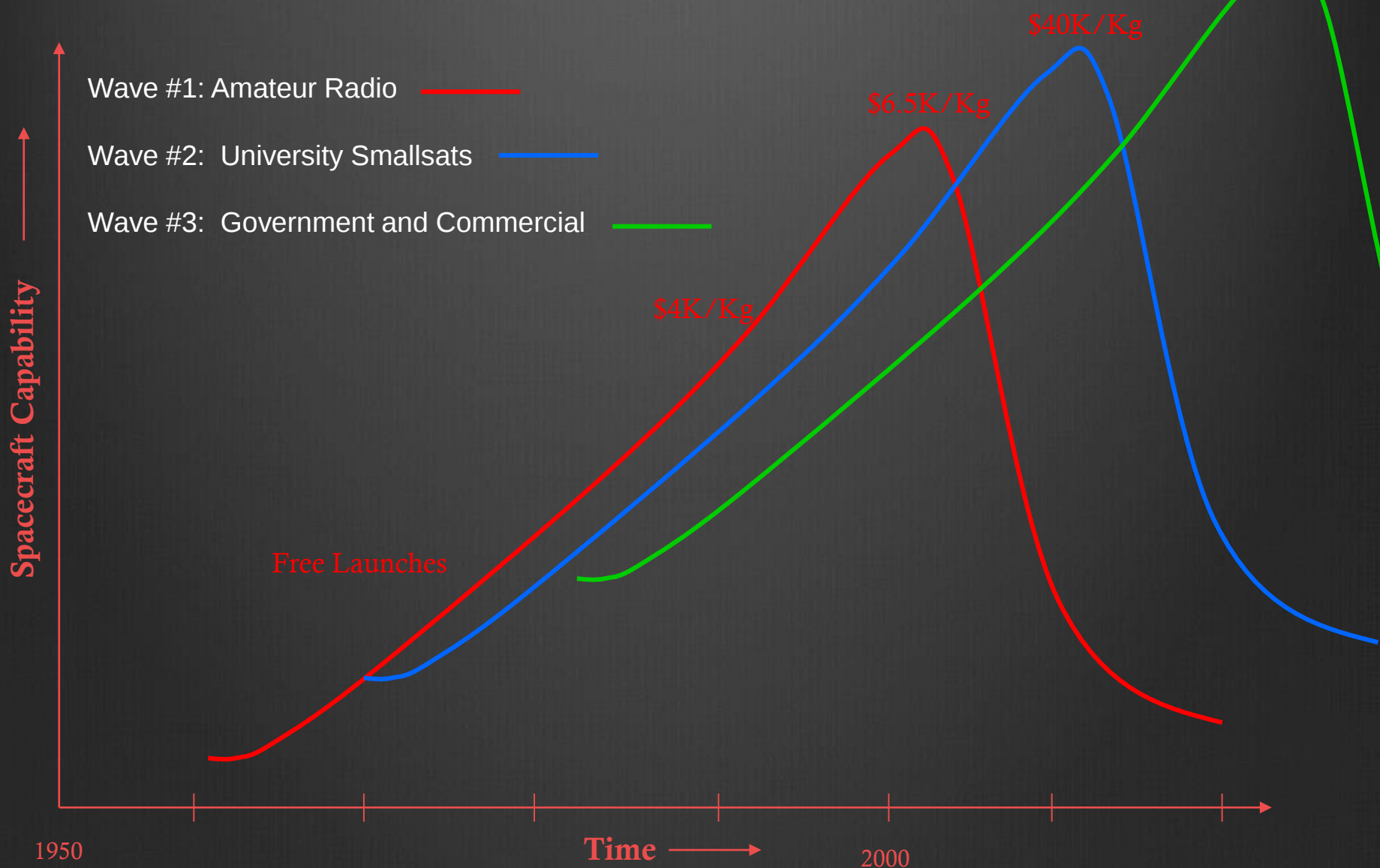
And, then What Happened, Daddy?

How Does the Story End?

AMSAT and Its OFFSPRING

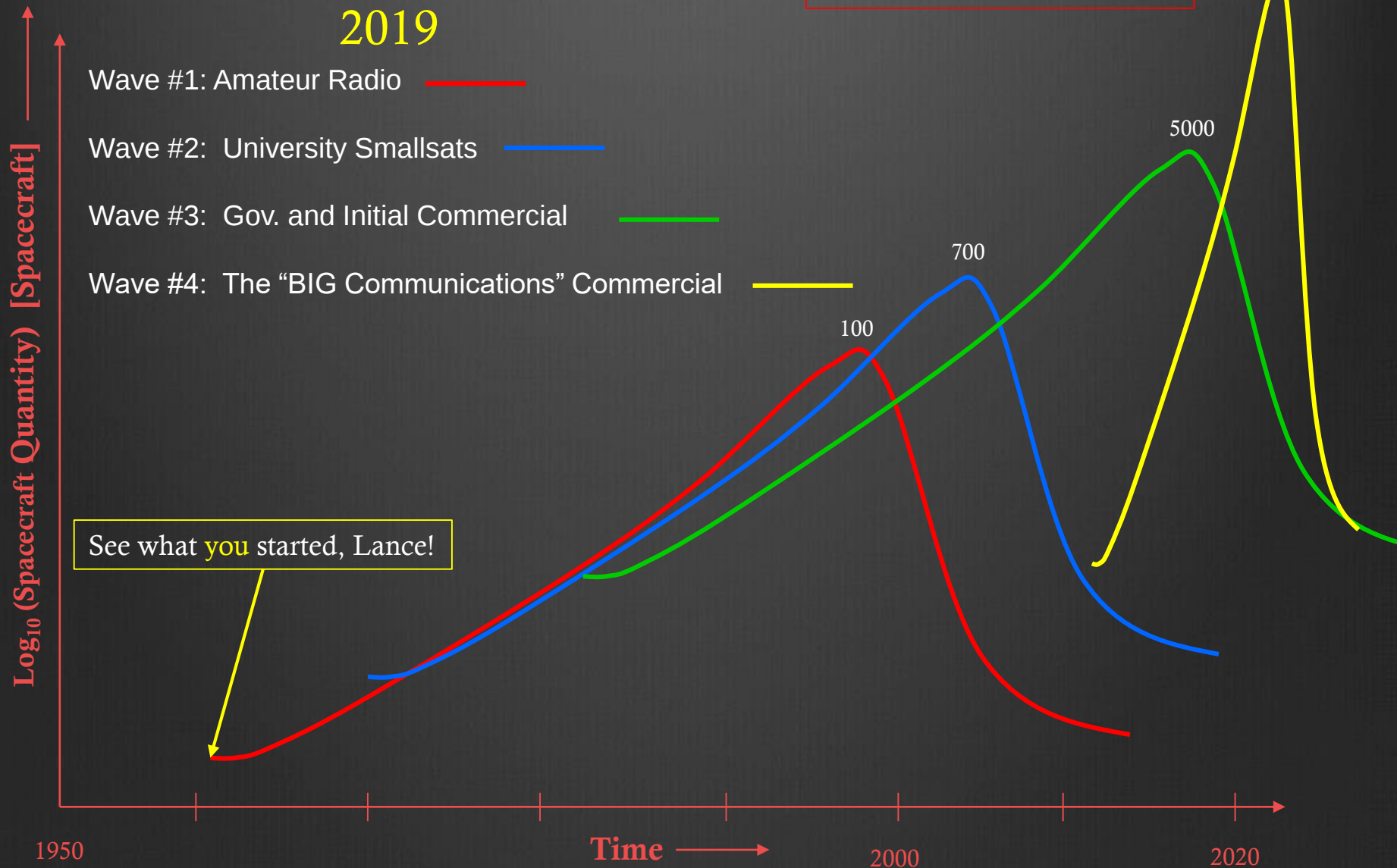


Jan King's View of the Small Satellite World in 2014*



* NOTE: Presented at 45th AGM

Jan King's View of the Small Satellite World in 2019



The Big Wave Commercial

- ⦿ The FCC has now Authorized > 22,500 small satellites to operate in LEO and MEO orbits in order to provide Internet Service to the “Other Three Billion” of us who don’t now have it.
- ⦿ The Commission Has Authorized 11 Applicants to Operate Stations in the USA.
- ⦿ The Numbers:
 - ⦿ Over 1300 small satellites were launched from 2012 thru 2018 by the educational, government and commercial sectors.
 - ⦿ Over 70% of these were CubeSats
 - ⦿ **Northern Sky Research** Forecasts this “market to yield **\$37 billion in cumulative revenues** from smallsat manufacturing and launch services by 2027, **with 6,500 smallsats** set to launch during this time.”



So, How Did We Do?

- Did we Meet All of Our Seven Objectives?
- In 50 Years, Did We Satisfy Our Goal to “Support the Public Interest?”
- Was it Worth the Investments We Made in Personal Time and Commitment? **Remember again, It's Only a Hobby!**
- Did we start something, or WHAT?
- As We Go Forward into the Next 50 Years, Should the Objectives be Change or Adjusted?

YOU DECIDE!